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# Association between breastfeeding and insulin sensitivity among young people with Type 1 and Type 2 diabetes: the SEARCH Nutrition Ancillary Study

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Decreased insulin sensitivity has been shown to be present in young people with Type 1 or Type 2 diabetes [1]. Approximately 20% of young people with Type 1 diabetes have decreased insulin sensitivity, which may be partly attributed to the rise in the prevalence of overweight and obesity in the population [2]. For individuals with Type 2 diabetes, decreased insulin sensitivity is an aetiological hallmark, but there is significant variability in insulin sensitivity even within this group [3]. Because decreased insulin sensitivity among young people with diabetes increases cardiovascular disease risk [4], identification of modifiable factors that preserve insulin sensitivity is important for improving long-term health.

Breastfeeding may improve health outcomes later in life [5, 6]. Beneficial effects may be attributed to differences between nutrient content in breast milk vs formula, and hormonal responses to bioactive compounds in human milk, energy intake levels and weight gain patterns in breastfed vs formula-fed infants [7]. Results from previous epidemiological studies examining the relationship between breastfeeding and insulin sensitivity have been

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**Competing interests**

None declared.

**Supporting information**

Additional Supporting Information may be found in the online version of this article:

Appendix S1 Supplementary methods, statistical analysis and references.

Table S1 Baseline characteristics of young people with Type 1 and Type 2 diabetes by categories of breastfeeding ($n$=1591).

inconsistent, and it is unclear whether breastfeeding would affect insulin sensitivity within individuals with either Type 1 or Type 2 diabetes.

We tested the hypothesis that higher breastfeeding prevalence and duration was associated with greater insulin sensitivity among young people with diabetes, using data collected by the SEARCH for Diabetes in Youth (SEARCH) study and the SEARCH Nutrition Ancillary Study (SNAS). The sample included 1751 young people with Type 1 diabetes and 204 young people with Type 2 diabetes. Breastfeeding was examined as a continuous (duration in months) and categorical variable [never breastfed (Type 1 diabetes, 30%; Type 2 diabetes, 65%); breastfed for < 6 months (Type 1 diabetes, 30%; Type 2 diabetes, 19%); and breastfed for ≥ 6 months (Type 1 diabetes, 40%; Type 2 diabetes, 16%)] [6]. Insulin sensitivity was estimated using an equation validated for young people with diabetes [8]. For young people with Type 1 diabetes, we defined low insulin sensitivity as an insulin sensitivity score lower than the 25$^{th}$ percentile for the National Health and Nutrition Examination Survey (NHANES) population (insulin sensitivity < 8.15) and high insulin sensitivity as an insulin sensitivity score ≥ the 25$^{th}$ percentile (insulin sensitivity ≥ 8.15) [1]. Because only 7% of young people with Type 2 diabetes had insulin sensitivity ≥ 8.15, insulin sensitivity was categorized into Type 2 diabetes-specific tertiles and defined as low (insulin sensitivity < 3.14), moderate (3.14 ≤ insulin sensitivity ≤ 5.04) and high (insulin sensitivity > 5.04). Details of the study participants, measurements and statistical analyses are described in the Supporting Information (Appendix S1).

Participant characteristics are shown in Table S1. Unadjusted logistic regression showed that, compared with those who were never breastfed, individuals who had been breastfed for < 6 months (odds ratio 1.60; 95% CI 1.20–2.21) and ≥ 6 months (odds ratio 1.60; 95% CI 1.23–2.16) had significantly higher odds of having high insulin sensitivity (Fig. 1); however, the association was attenuated and no longer significant after adjustment for covariates. Interactions of breastfeeding with human leukocyte antigen risk alleles and age at diagnosis were not significant ($P \geq 0.10$). Regression models using continuous breastfeeding duration and insulin sensitivity showed similar findings.

Among participants with Type 2 diabetes, unadjusted logistic regression showed that, compared with those who were never breastfed, individuals who had been breastfed for < 6 months (odds ratio 0.55; 95% CI 0.24–1.26) and ≥ 6 months (odds ratio 0.93; 95% CI 0.41–2.09) did not have significantly higher odds of having high insulin sensitivity (Fig. 1). Additional adjustment for covariates and models using continuous breastfeeding duration and insulin sensitivity also showed null results.

In our study, breastfeeding prevalence and duration was associated with insulin sensitivity in unadjusted but not adjusted models for individuals with Type 1 diabetes. No associations were identified for individuals with Type 2 diabetes, although the sample size was smaller. Findings from other observational studies have been mixed, with both positive [9] and null associations reported [5]. Differences across studies may be attributed to population differences, sample size or the methods used to assess and categorize insulin sensitivity. Further, observational studies of breastfeeding and insulin sensitivity have been criticized on the basis of residual confounding. A recent large clinical trial among healthy infants in

Belarus, however, found no association between breastfeeding and insulin sensitivity in childhood [10], suggesting that positive associations reported from observational studies may be attributable to residual confounding.

Our study had some limitations and strengths. First, breastfeeding duration relied on maternal recall and it is possible that mothers of young people with low insulin sensitivity differentially recalled breastfeeding duration. Second, it is possible that breastfeeding may influence insulin sensitivity at early ages or concomitantly with breastfeeding, which was not captured in our study. Finally, we did not adjust for use of metformin which may increase insulin sensitivity. Use of data from the SEARCH and SNAS studies allowed us to examine potential associations among a diverse contemporary sample of young people with Type 1 diabetes and Type 2 diabetes. Most research in this area has been conducted in individuals without diabetes, precluding the generalizability of findings to individuals with diabetes. Additionally, the availability of a validated measure of insulin sensitivity [1,8] is a major strength of our study.

In conclusion, our findings suggest that breastfeeding is not associated with improved insulin sensitivity during childhood for individuals with diabetes. Additional studies to identify modifiable factors that improve insulin sensitivity in this high-risk population are warranted.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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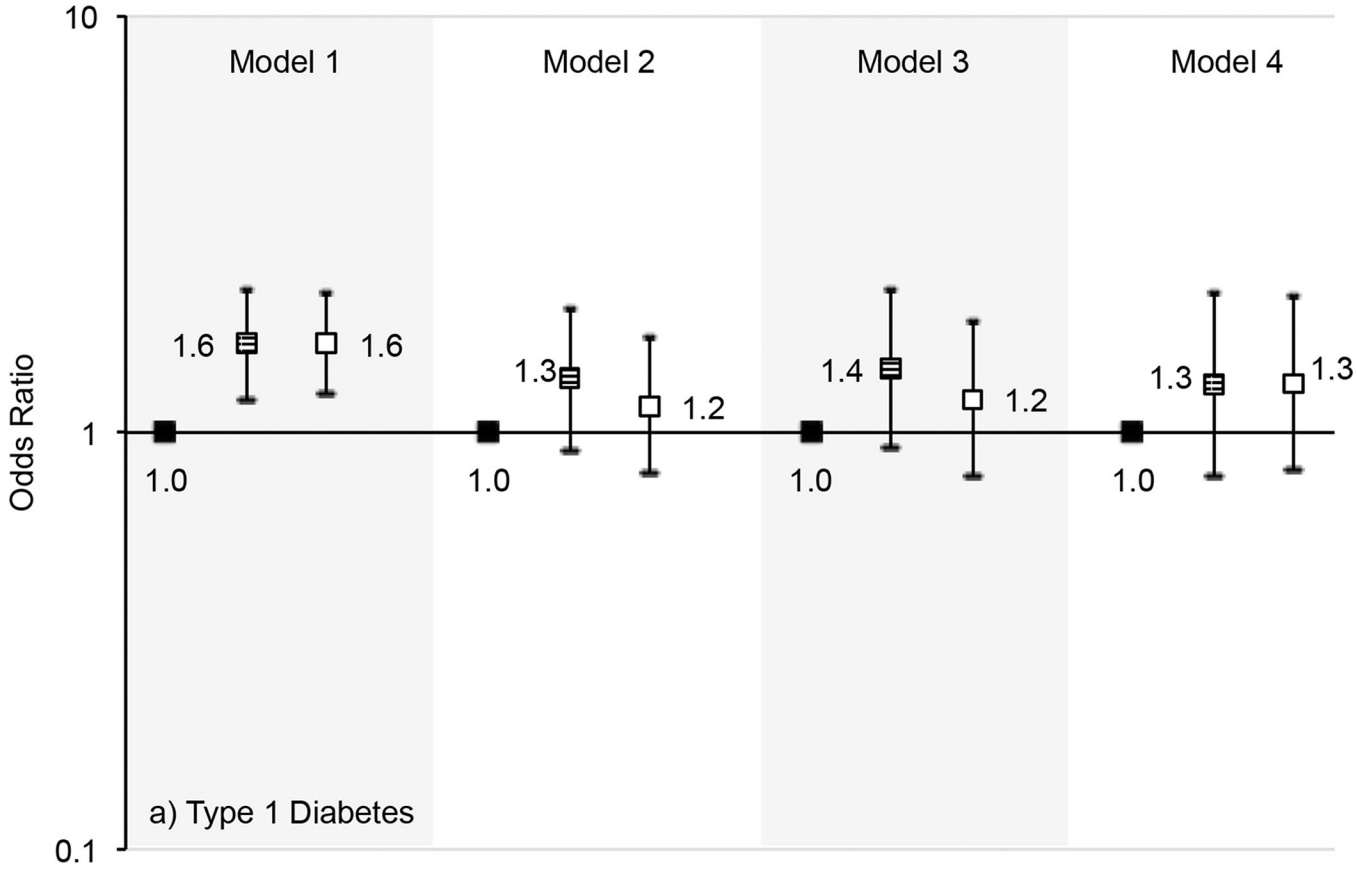

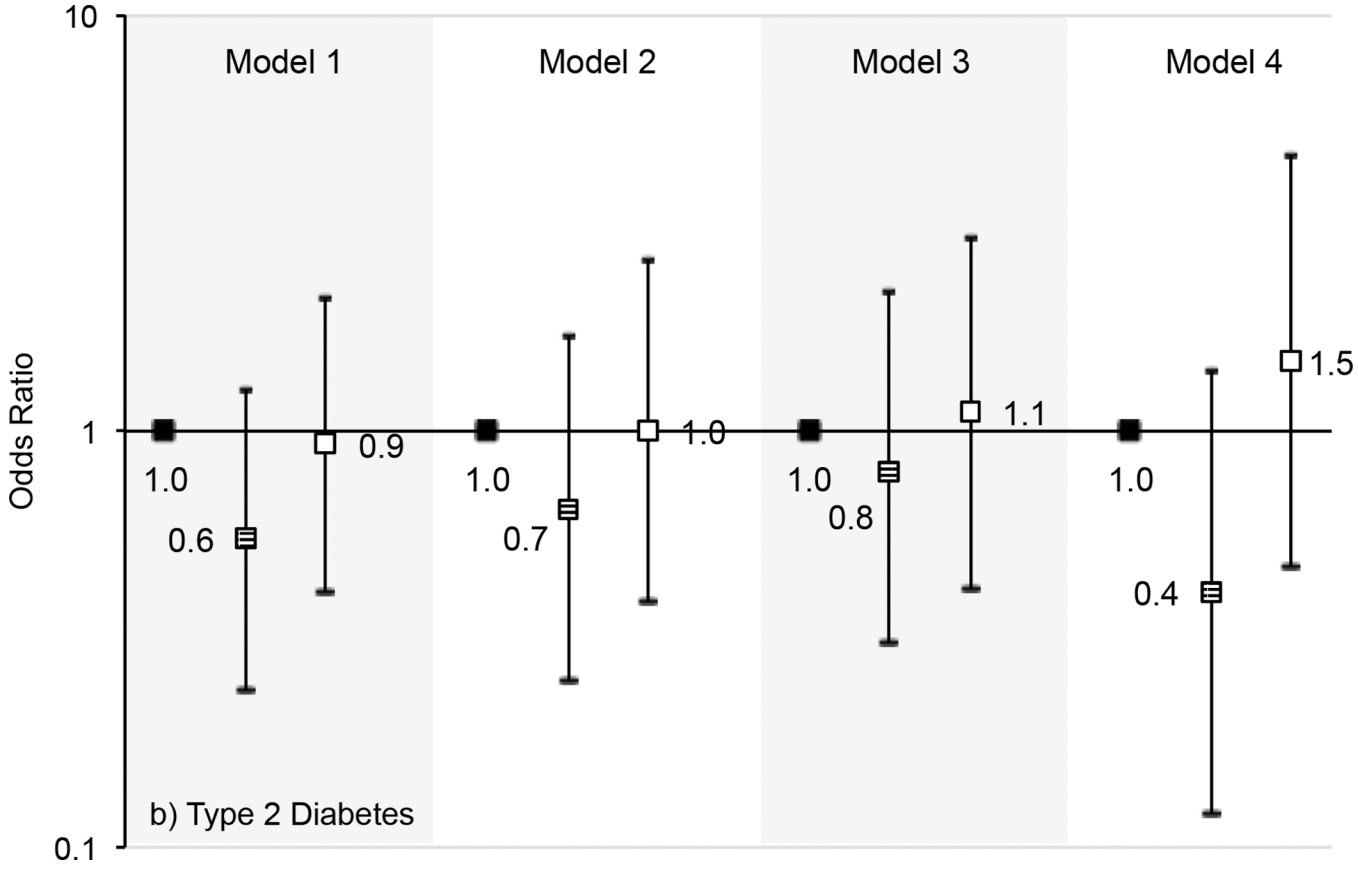


**Figure 1.**

(a) Type 1 diabetes: Model 1: unadjusted; Model 2: adjusted for gender (male or female), race/ethnicity (non-Hispanic white, non-Hispanic black, or other), parental education (lower than high school, high school graduate, some college, or bachelor's degree or higher level), household income (<$25,000, $25,000–$49,999, $50,000–$74,999, ≥$75,000, or refused/don't know), and clinic site (California, Colorado, Hawaii, Ohio, South Carolina or Washington); Model 3: Model 2 + age at diagnosis (continuous), duration of diabetes (continuous), insulin regimen [pump, long and short/rapid insulin (≥ 3 times/day)], long and any other combination (≥ 2 times/day), any combination of insulin excluding long (≥ 3 times/day), or any insulin taken 1 time/day or any insulin combination excluding long 2 times/day), and HLA risk groups (high/moderate risk or low risk); Model 4: Model 3 + BMI z-score. (b) Type 2 diabetes: Model 1: unadjusted; Model 2: adjusted for gender (male or female), race/ethnicity (non-Hispanic white, non-Hispanic black, or other), parental education (lower than high school, high school graduate, some college, or bachelor's degree or more), household income (<$25,000, $25,000–$49,999, $50,000–$74,999, ≥$75,000, or refused/don't know), and clinic site (California, Colorado, Hawaii, Ohio, South Carolina or Washington); Model 3: Model 2 + age at diagnosis (continuous) and duration of diabetes (continuous); Model 4: Model 3 + BMI z-score.